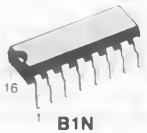
SGS-THOMSON MICROELECTRONICS

M54/74HC160/161
M54/74HC162/163

SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- HIGH SPEED
  f_{MAX} = 50 MHz (TYP.) at V_{CC} = 5V
- LOW POWER DISSIPATION
  I_{CC} = 4 μA (MAX.) at 25°C
- OUTPUT DRIVE CAPABILITY
  10 LSTTL LOADS
- BALANCED PROPAGATION DELAYS
  t_{PLH} = t_{PHL}
- HIGH NOISE IMMUNITY
  V_{NIH} = V_{NIL} = 28% V_{CC} (MIN).
- WIDE OPERATING VOLTAGE RANGE
  V_{CC} (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE
  WITH 54/74LS160 ~ 163



B1N
Plastic Package

F1
Ceramic Frit Seal Package

M1
Micro Package

C1
Plastic Chip Carrier

ORDERING NUMBERS:

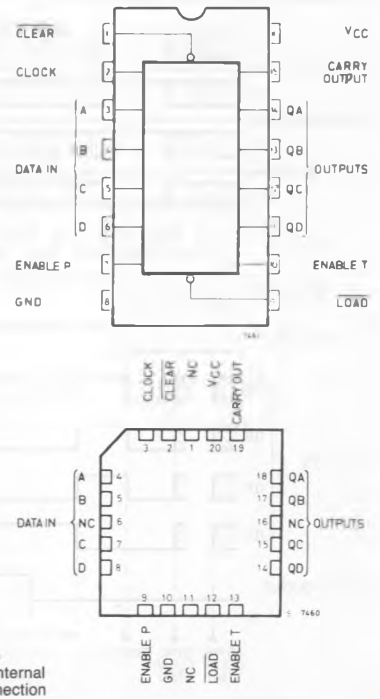
M54HCXXX F1
M74HCXXX B1N
M74HCXXX F1
M74HCXXX C1
M74HCXXX M1

DESCRIPTION

M54/74HC160 Decade, Asynchronous Clear
M54/74HC161 Binary, Asynchronous Clear
M54/74HC162 Decade, Synchronous Clear
M54/74HC163 Binary, Synchronous Clear

The M54/74HC160, 161, 162 and 163 are high speed CMOS SYNCHRONOUS PRESETTABLE COUNTERS fabricated with silicon gate C²MOS technology.
They have the same the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.
The M54/74HC160/162 are BCD Decade counters and the M54/74HC161/163 are 4 bit binary counters.
The CLOCK input is active on the rising edge. Both $\overline{\text{LOAD}}$ and $\overline{\text{CLEAR}}$ inputs are active Low.
Presetting of all four IC's is synchronous on the rising edge of the CLOCK.
The function on the M54/74HC162/163 is synchronous to CLOCK, while the M54/74HC160/161 counters are cleared asynchronously.
Two enable inputs (TE and PE) and CARRY output are provided to enable easy cascading of counters, which facilities easy implementation of N-bit counters without using external gates.
All inputs are equipped with protection circuits against static discharge and transient excess voltage.

PIN CONNECTIONS (top view)



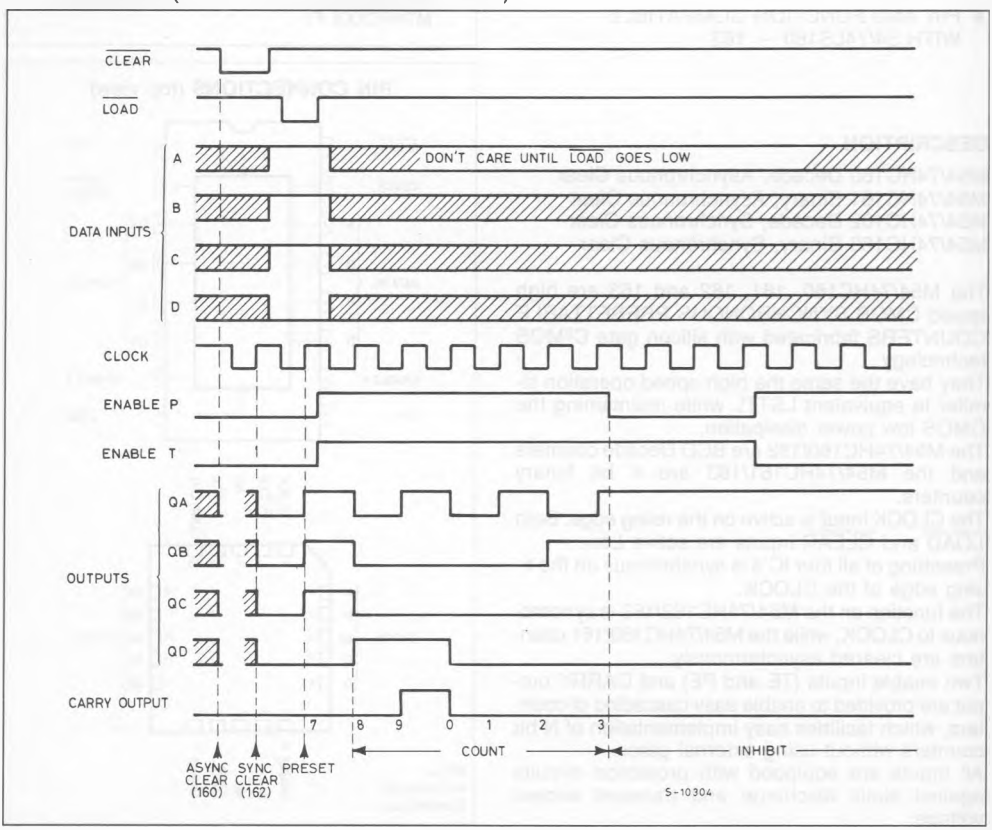
NC = No Internal Connection

TRUTH TABLE

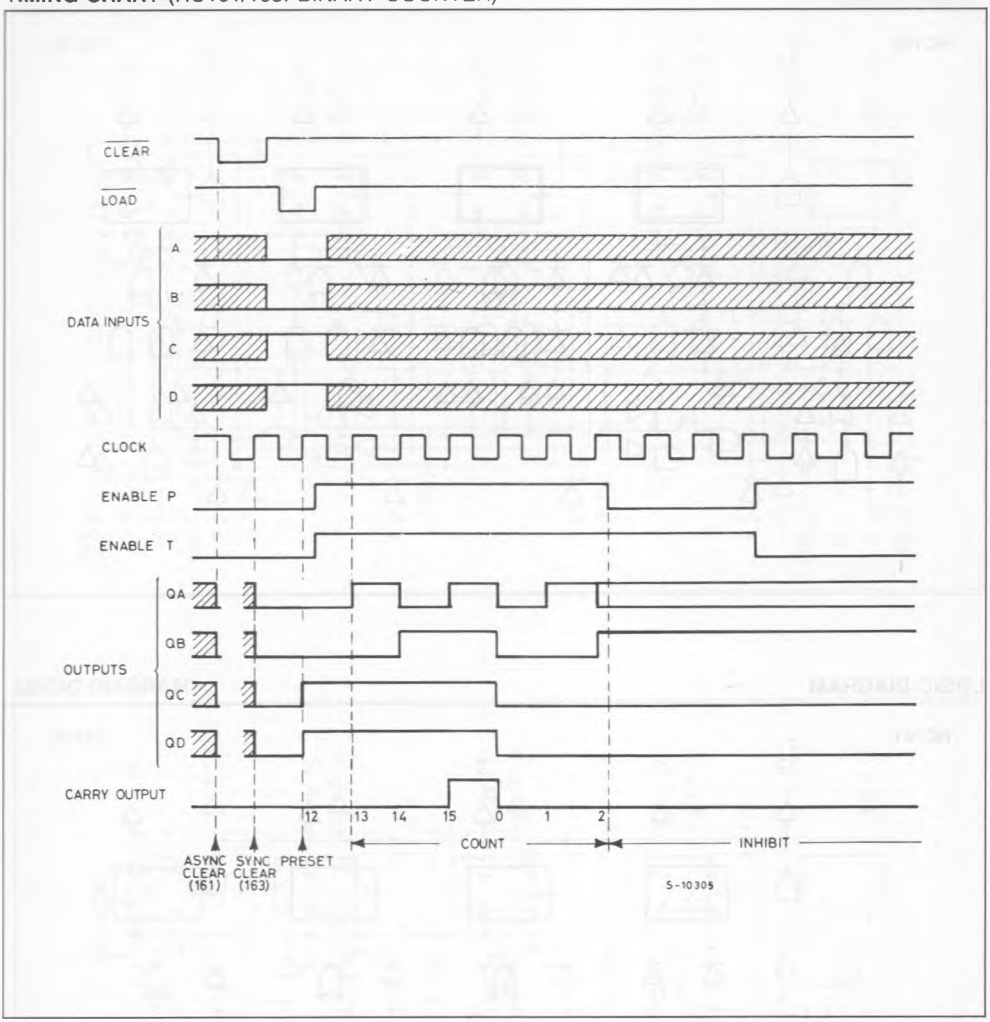
M54/74HC160/161					M54/74HC162/163					OUTPUTS				FUNCTION
INPUTS					INPUTS									
$\overline{CLR}$	$\overline{LD}$	PE	TE	CK	$\overline{CLR}$	$\overline{LD}$	PE	TE	CK	QA	QB	QC	QD	
L	X	X	X	X	L	X	X	X	↓	L	L	L	L	RESET TO "0"
H	L	X	X	↑	H	L	X	X	↑	A	B	C	D	PRESET DATA
H	H	X	L	↑	H	H	X	L	↑	NO CHANGE				NO COUNT
H	H	L	X	↑	H	H	L	X	↑	NO CHANGE				NO COUNT
H	H	H	H	↑	H	H	H	H	↑	COUNT UP				COUNT
H	X	X	X	↓	X	X	X	X	↓	NO CHANGE				NO COUNT

Note X ; DON'T CARE
A, B, C, D ; LOGIC LEVEL OF DATA INPUTS
Carry : CARRY = TE • Q_A • $\overline{Q_B}$ • $\overline{Q_C}$ • Q_D ..... (M54/74HC160/162)
CARRY = TE • Q_A • Q_B • Q_C • Q_D ..... (M54/74HC161/163)

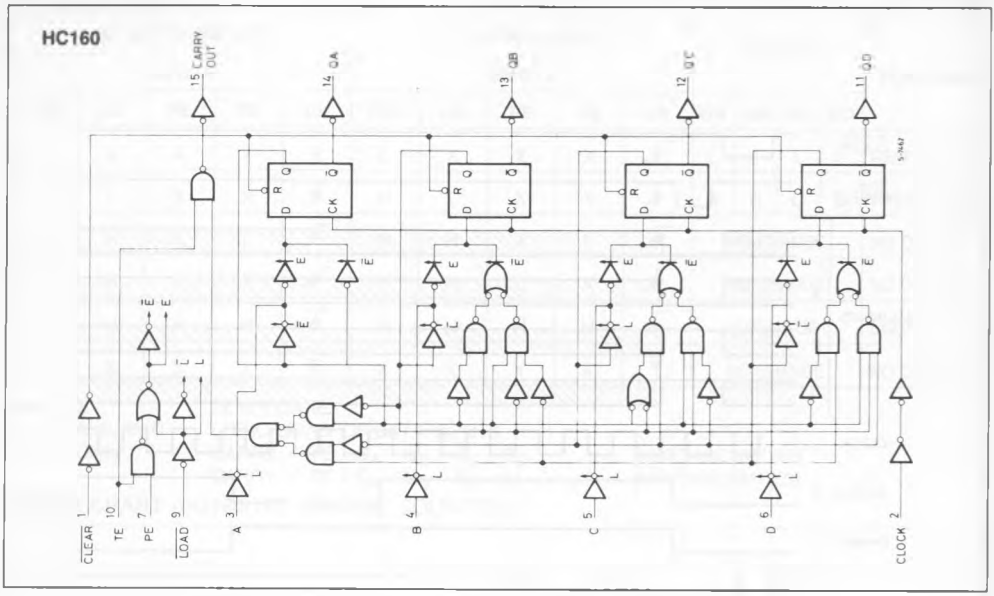
TIMING CHART (HC160/162: DECADE COUNTER)



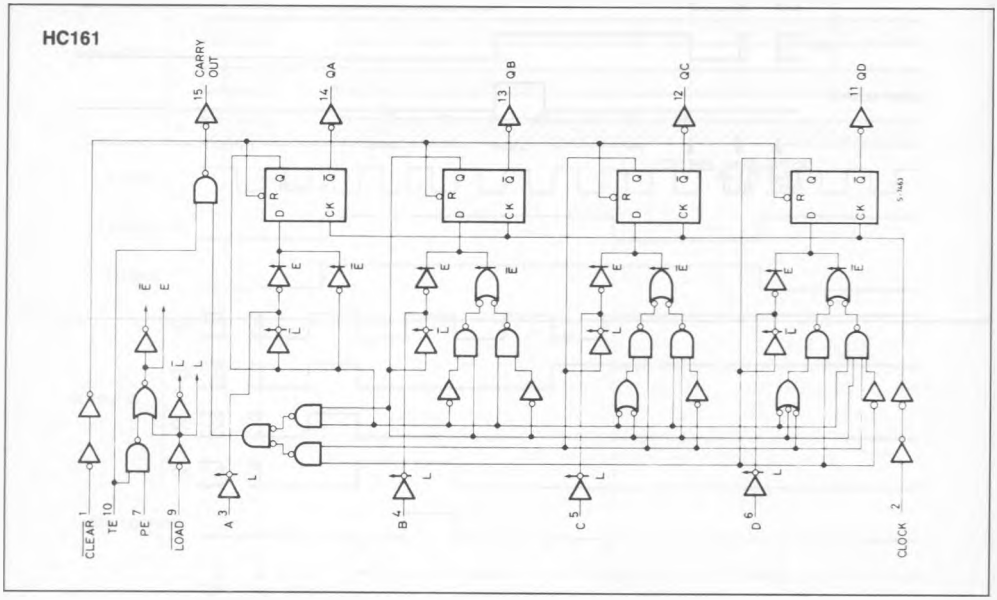
TIMING CHART (HC161/163: BINARY COUNTER)



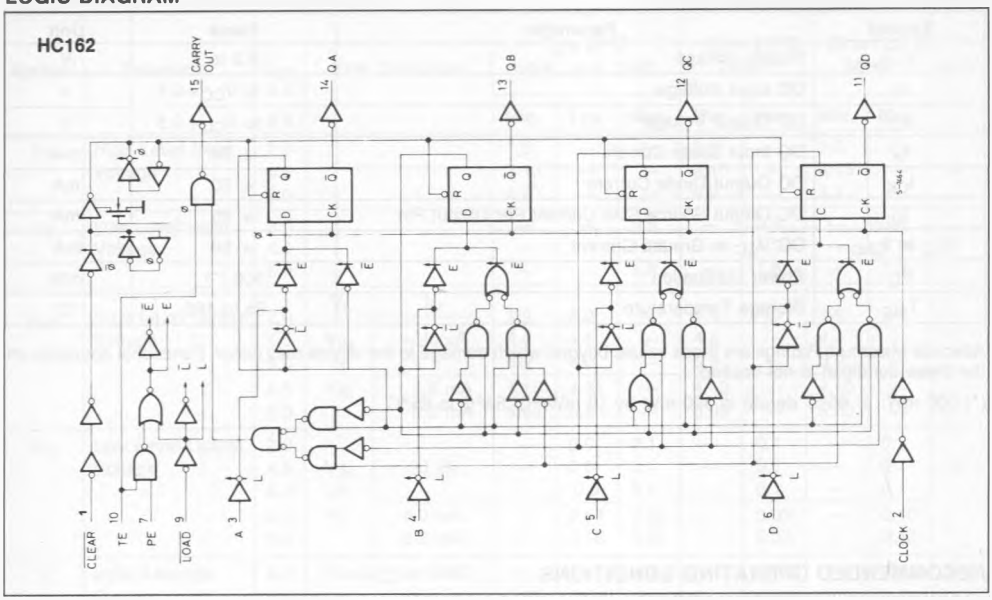
LOGIC DIAGRAM



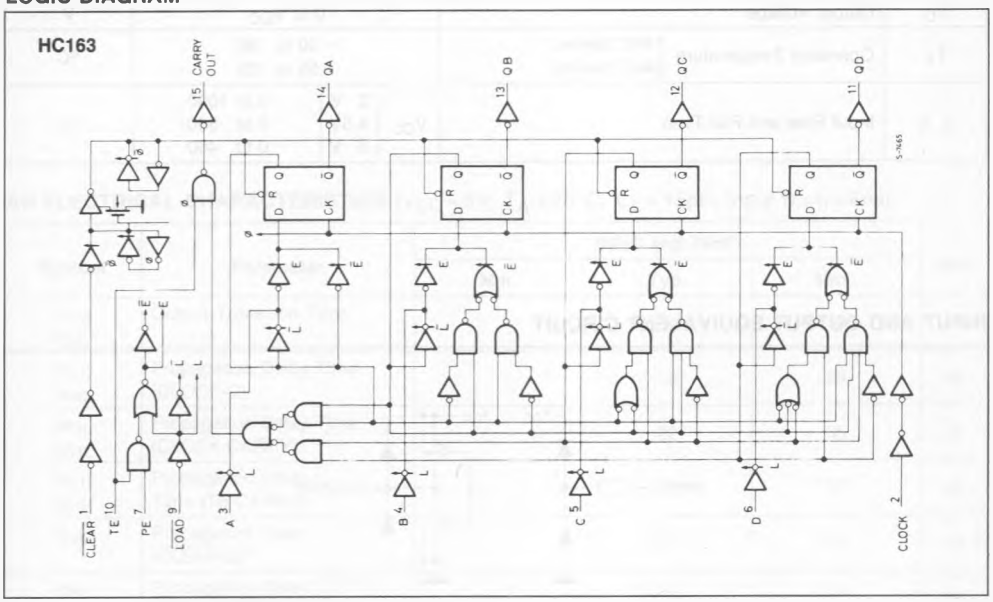
LOGIC DIAGRAM



LOGIC DIAGRAM



LOGIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	− 0.5 to 7	V
V_I	DC Input Voltage	− 0.5 to V_{CC} + 0.5	V
V_O	DC Output Voltage	− 0.5 to V_{CC} + 0.5	V
I_{IK}	DC Input Diode Current	± 20	mA
I_{OK}	DC Output Diode Current	± 20	mA
I_O	DC Output Source Sink Current Per Output Pin	± 25	mA
I_{CC} or I_{GND}	DC V_{CC} or Ground Current	± 50	mA
P_D	Power Dissipation	500 (*)	mW
T_{stg}	Storage Temperature	− 65 to 150	°C

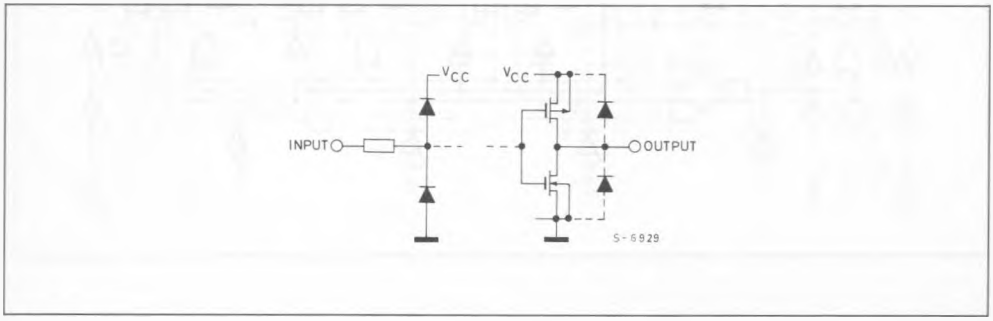
Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

(*) 500 mW: ≅ 65°C derate to 300 mW by 10 mW/°C: 65°C to 85°C.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter		Value		Unit
V_{CC}	Supply Voltage		2 to 6		V
V_I	Input Voltage		0 to V_{CC}		V
V_O	Output Voltage		0 to V_{CC}		V
T_A	Operating Temperature	74HC Series 54HC Series	− 40 to 85 − 55 to 125		°C
t_r, t_f	Input Rise and Fall Time		V_{CC} = 2 V	0 to 1000	ns
			V_{CC} = 4.5V	0 to 500	
			V_{CC} = 6 V	0 to 400	

INPUT AND OUTPUT EQUIVALENT CIRCUIT



DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	V_{CC}	Test Condition		$T_A = 25°C$ 54HC and 74HC			−40 to 85°C 74HC		−55 to 125°C 54HC		Unit
					Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
V_{IH}	High Level Input Voltage	2.0			1.5	—	—	1.5	—	1.5	—	V
		4.5			3.15	—	—	3.15	—	3.15	—	
		6.0			4.2	—	—	4.2	—	4.2	—	
V_{IL}	Low Level Input Voltage	2.0			—	—	0.5	—	0.5	—	0.5	V
		4.5			—	—	1.35	—	1.35	—	1.35	
		6.0			—	—	1.8	—	1.8	—	1.8	
V_{OH}	High Level Output Voltage	2.0	V_I	I_O	1.9	2.0	—	1.9	—	1.9	—	V
		4.5	V_{IH} or V_{IL}	−20 μA	4.4	4.5	—	4.4	—	4.4	—	
		6.0			5.9	6.0	—	5.9	—	5.9	—	
		4.5		−4.0 mA	4.18	4.31	—	4.13	—	4.10	—	
		6.0		−5.2 mA	5.68	5.8	—	5.63	—	5.60	—	
V_{OL}	Low Level Output Voltage	2.0	V_{IH} or V_{IL}	20 μA	—	0.0	0.1	—	0.1	—	0.1	V
		4.5			—	0.0	0.1	—	0.1	—	0.1	
		6.0			—	0.0	0.1	—	0.1	—	0.1	
		4.5		4.0 mA	—	0.17	0.26	—	0.33	—	0.40	
		6.0		5.2 mA	—	0.18	0.26	—	0.33	—	0.40	
I_I	Input Leakage Current	6.0	$V_I = V_{CC}$ or GND		—	—	±0.1	—	±1.0	—	±1.0	μA
I_{CC}	Quiescent Supply Current	6.0	$V_I = V_{CC}$ or GND		—	—	4	—	40	—	80	μA

AC ELECTRICAL CHARACTERISTICS ($V_{CC} = 5V$, $T_A = 25°C$, $C_L = 15pF$, Input $t_r = t_f = 6ns$)

Symbol	Parameter	54HC and 74HC			Unit
		Min.	Typ.	Max.	
t_{TLH} t_{THL}	Output Transition Time		4	8	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK-Q)		18	28	ns
t_{PHL} t_{PHL}	Propagation Delay Time (CLOCK-CARRY)		22	35	ns
t_{PLH} t_{PHH}	Propagation Delay Time (TE-CARRY)		10	17	ns
t_{PHL}	Propagation Delay ($\overline{CLEAR}$-Q)*		21	33	ns
t_{PHL}	Propagation Delay time ($\overline{CLEAR}$-CARRY)		23	37	ns
f_{MAX}	Maximum Clock Frequency	30	50		MHz

AC ELECTRICAL CHARACTERISTICS (C_L = 50pF, Input $t_r = t_f$ = 6ns)

Symbol	Parameter	V_{CC}	Test Condition	T_A = 25°C 54HC and 74HC			−40 to 85°C 74HC		−55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_{TLH} t_{THL}	Output Transition Time	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - Q)	2.0 4.5 6.0		— — —	88 22 19	165 33 28	— — —	205 41 35	— — —	250 50 43	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK-CARRY)	2.0 4.5 6.0		— — —	104 26 22	200 40 34	— — —	250 50 43	— — —	300 60 51	ns
t_{PLH} t_{PHL}	Propagation Delay Time (TE-CARRY)	2.0 4.5 6.0		— — —	52 13 11	100 20 17	— — —	125 25 21	— — —	150 30 26	ns
t_{PHL}	Propagation Delay Time ($\overline{CLEAR}$-Q)•	2.0 4.5 6.0		— — —	100 25 21	185 37 31	— — —	230 46 39	— — —	280 56 48	ns
t_{PHL}	Propagation Delay Time ($\overline{CLEAR}$-CARRY)•	2.0 4.5 6.0		— — —	112 28 24	210 42 36	— — —	265 53 45	— — —	315 63 54	ns
f_{MAX}	Maximum Clock Frequency	2.0 4.5 6.0		5.4 27 32	11 45 53	— — —	4.4 22 26	— — —	3.5 18 21	— — —	MHz
$t_{W(H)}$ $t_{W(L)}$	Minimum Pulse Width (CLOCK)	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
$t_{W(L)}$	Minimum Pulse Width ($\overline{CLEAR}$)•	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_s	Minimum Set-up Time ($\overline{LOAD}$ PE, TE	2.0 4.5 6.0		— — —	50 13 11	125 25 21	— — —	155 31 26	— — —	190 38 22	ns
t_s	Minimum Set-up Time (A,B,C,D)	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_s	Minimum Set-up Time ($\overline{CLEAR}$) ••	2.0 4.5 6.0		— — —	35 9 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_h	Minimum Hold Time	2.0 4.5 6.0		— — —	— — —	0 0 0	— — —	0 0 0	0 0 0	0 0 0	ns

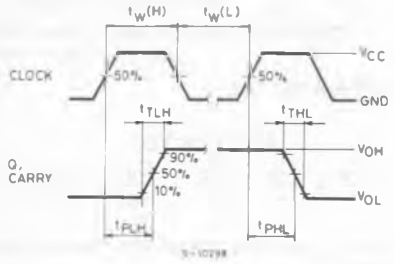
AC ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	V_{CC}	Test Condition	T_A = 25°C 54HC and 74HC			−40 to 85°C 74HC		−55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_{REM}	Minimum Time (CLEAR)•	2.0		—	5	50	—	65	—	75	ns
		4.5		—	1	10	—	13	—	15	
		6.0		—	1	9	—	11	—	13	
C_{IN}	Input Capacitance			—	5	7.5	—	7.5	—	—	pF
C_{PD} (*)	Power Dissipation Capacitance			—	57	—	—	—	—	—	pF

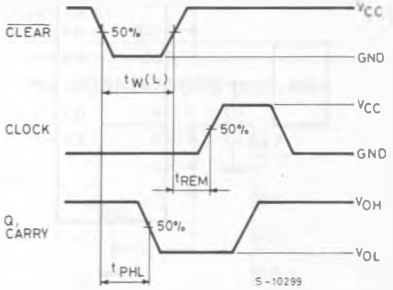
Note (*) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the following equation.
I_{CC} (Opr) = C_{PD} • V_{CC} • f_{IN} + I_{CC} •: for M54/74HC160/161 only ••: for M54/74HC162/163 only

SWITCHING CHARACTERISTICS TEST WAVEFORM

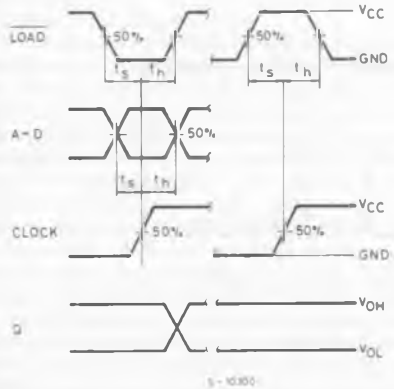
COUNT MODE



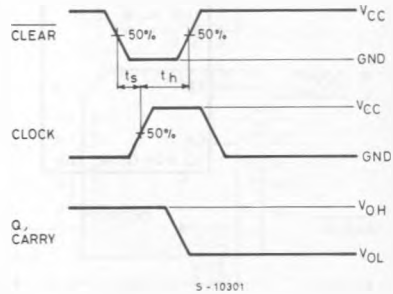
CLEAR MODE (HC160/161)



PRESET MODE

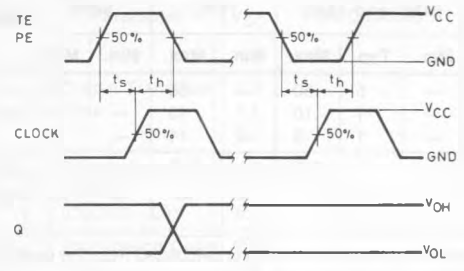


CLEAR MODE (HC162/163)



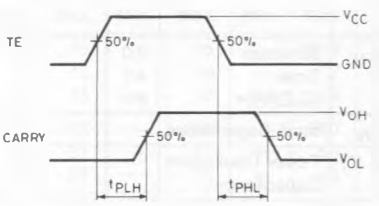
SWITCHING CHARACTERISTICS TEST WAVEFORM (Continued)

COUNT ENABLE MODE



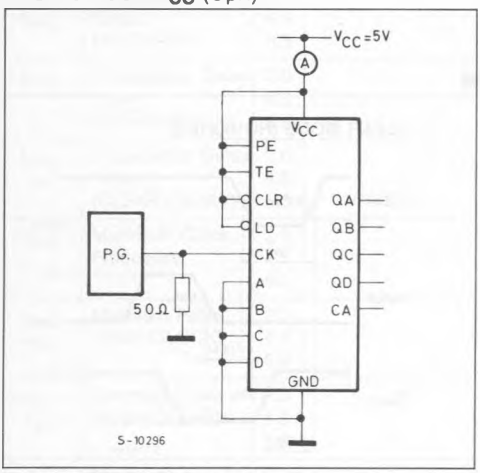
S-10302

CASCADE MODE
(Fix Maximum Count)



S-10303

TEST CIRCUIT I_{CC} (Opr.)



S-10296

TOTAL OPERATING CURRENT WHEN USING A CAPACITIVE LOAD

When the outputs drive a capacitive load, the total current can be calculated as follows:
For M74HC160/162:

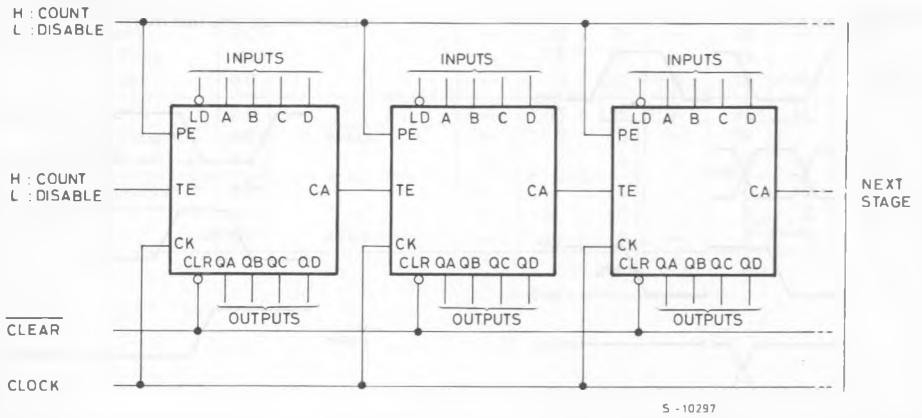
$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \cdot \left(\frac{C_a}{2} + \frac{C_b}{5} + \frac{C_c}{10} + \frac{C_d}{10} + \frac{C_{ca}}{10} \right)$$

For M74HC161/163

$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \cdot \left(\frac{C_a}{2} + \frac{C_b}{4} + \frac{C_c}{8} + \frac{C_d}{16} + \frac{C_{ca}}{16} \right)$$

C_a to C_{ca} are the capacitors loading the outputs.

TYPICAL APPLICATION



S-10297